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# IS 11778-1 (1987): Low Frequency, Threaded Coupling, Circular Connectors, Part 1: Test Schedule and Requirements [LITD 3: Electromechanical COmponents and Mechnical Structures for Electronic Equipment]

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**IS 11778 ( Part 1 ) - 1987**
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# *Indian Standard*

# SPECIFICATION FOR LOW FREQUENCY, THREADED COUPLING, CIRCULAR CONNECTORS

## PART 1 TEST SCHEDULE AND REQUIREMENTS

UDC 621·315·683·029·42/·53 : 621·38/·39·038

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 7 *February* 1988

# *Indian Standard*

# SPECIFICATION FOR LOW FREQUENCY, THREADED COUPLING, CIRCULAR CONNECTORS

## PART 1 TEST SCHEDULE AND REQUIREMENTS

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( *Continued on page* 2 )

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# *Indian Standard*

# SPECIFICATION FOR LOW FREQUENCY, THREADED COUPLING, CIRCULAR CONNECTORS

## PART 1 TEST SCHEDULE AND REQUIREMENTS

## 0. FOREWORD

**0.1** This Indian Standard ( Part 1 ) was adopted by the Bureau of Indian Standards on 31 July 1987, after the draft finalized by the Connectors for Electronics Equipment Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

**0.2** This standard ( Part 1 ) is one of the Indian Standards on low frequency connectors below 3 MHz used in electronic equipment and shall be used in conjuction with IS : 9647-1986*. Subsequent parts of this standard will cover detailed specifications for specific types of connectors.

**0.3** While preparing this standard, assistance has been derived from JSS 50812 Detail specification for connectors, electrical, circular, threaded coupling, issued by the Directorate of Standardization, Ministry of Defence, India.

**0.4** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

## 1. SCOPE

**1.1** This standard ( Part 1 ) specifies the test schedule and requirements applicable to low frequency ( below 3 MHz including dc ) threaded coupling circular connectors.

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*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

†Rules for rounding off numerical values ( *first revision* ).

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, terms and definitions given in IS : 1885 ( Part 40 )-1974* and IS : 9647-1986† shall apply.

## 3. MATERIALS AND WORKMANSHIP

**3.1** The materials used and workmanship shall be in accordance with **4** of IS : 9647-1986†.

**3.2 Dissimilar Metals** — When dissimilar metals are employed in intimate contact with each other in a connector or in a mated pair of connectors, suitable protection against electrolytic corrosion shall be provided.

**3.3 Non-Magnetic Materials (except Hermetically Sealed and Fireproof Connectors )** — All parts shall be made of the materials which are classed as non-magnetic except for hermetically sealed and fireproof connectors.

**3.4 Contact Materials** — Contacts shall be made of suitable conductive materials. Contacts for hermetically sealed connectors may be ferrous alloy. Thermocouple contacts shall be made of a material compatible with the thermocouple wire to which attachment is intended and may be magnetic.

**3.4.1** *Contact Plating ( Solder Type except Hermetically Sealed )* — Contacts shall be silver plated or gold plated over silver plating. The resultant minimum thickness of plating shall be 2·54 micrometres. Accessory members of the female contacts need not be plated but shall comply with the requirements of **3.2**.

**3.4.2** *Contact Plating ( Hermetically Sealed Connectors )* — Contacts shall be gold plated to a thickness of 1·27 micrometres, minimum. A suitable underplating shall be used.

**3.4.3** *Contact Plating ( Crimp Type )* — *See* the relevant specification.

**3.4.4** *Contact Plating ( Thermocouple )* — Thermocouple contacts may be cadmium plated or otherwise suitably protected from corrosion. Accessory members of female contacts need not be plated but shall comply with the requirements for dissimilar metals as in **3.2**.

### 3.5 Dielectric Materials

**3.5.1** *Insert and Grommet* — Inserts and grommets shall be high grade dielectric having hardness, electrical and mechanical characteristics suitable for the purpose intended.

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*Electrotechnical vocabulary : Part 40 Connectors.

†General requirements and methods of tests for low frequency connectors below 3MHz including dc ( *first revision* ).

3.5.2 *Connectors Environment Resistant Solder Contact* — The mating faces of inserts of solder contact connectors shall be resilient materials within a Shore A durometer range of 60 to 85. On crimp contact front release connectors, the Shore A durometer range shall be 35 to 85 for a minimum thickness of 2·29 mm. On rear release style connectors, the Shore A durometer range shall be 35 to 85 for a minimum thickness of 2·29 mm.

3.5.3 *Hermetically Sealed Connector* — The hermetic sealing of connectors shall be accomplished by the use of vitreous material. The mating faces of inserts shall be a resilient materials with a Shore A durometer range of 35 to 55.

**3.6 Design and Construction** — Connectors and accessories shall be designed and constructed to withstand normal handling incident to installation and maintenance in service. The back end design and configuration of removable crimp contact connectors shall conform to the relevant specification. Removable crimp contact connector interchangeability control dimensions shall conform to the relevant specification.

3.6.1 *Contacts* — Contacts shall conform to the requirements of the specification. Contacts shall be so designed that neither male nor female contact will be damaged during mating of counterpart connectors.

3.6.1.1 *Solder contacts* — Solder type male and female contacts sizes 0 and 4, may be so designed that they can be readily removed from their inserts for soldering to their conductors and readily re-assembled after the soldered connection has been made. Contact size 8 need not be removable for soldering purposes but may be replaceable. Male contacts sizes 12 and 16, may be rigidly mounted in their inserts. Inserts containing non-removable contacts shall not be subject to damage by soldering under an acceptable soldering process. For dimensions of male and female contacts, *see* Appendix A.

3.6.1.2 *Solder cups* — Solder cup shall be so designed that during soldering, no component will be damaged and no liquid will escape. The solder cups of size 0, 4 and 8 shall be provided with a vent hole or with equivalent provisions to prevent trapping of air during soldering. The interior surface of solder cup, except in thermocouple contacts, for size 16 and 12, shall be completely tinned over 100 percent of full circle portion and for at least 50 percent of the remainder of the solder well area, and for sizes 0, 4 and 8, the interiors shall be completely tinned. Only alcohol and resin shall be used as flux. No excess solder shall be on the exterior of the solder cup.

**3.6.1.3** *Crimp contacts* — Crimp contacts shall be designed to prevent damage to the contact retention device or sealing member during insertion or removal of the contact.

**3.6.1.4** *Insertion and removal tool* — The individual contacts shall be positively retained in the connector when installed with the applicable insertion tool. The individual contacts shall be capable of being removed from the connector when using the applicable contact removal tool.

**3.6.2** *Insert Design and Construction* — Inserts shall be of voidless construction and secured to prevent rotation within the shell.

**3.6.2.1** *Resilient inserts* — All resilient inserts shall be non-removable from the shell.

**3.6.2.2** *Insert positioning* — Removable inserts shall be keyed to prevent rotation with respect to the shell. Slots and markings for any of the alternate position, as well as specific design details shall be indicated in the relevant specification.

**3.6.2.3** *Inserts for crimp contact connectors* — The insert and wire sealing grommet or insulating spacer of crimp contact connectors shall be one integral part and shall permit the removal and re-insertion of individual contacts without damage to the sealing members.

**3.6.2.4** *Contact arrangement* — Contacts shall be arranged in accordance with the applicable specification. Except for contacts in hard inserts, all solder cup openings, regardless of insert position, shall be oriented at right angle to and facing towards key or keyway of the shell.

**3.6.2.5** *Contact spacing* — Unless otherwise specified, minimum mechanical spacing and creepage distance shall be as given in Table 1.

**TABLE 1 CONTACT SPACING**

| SERVICE RATING | MINIMUM CONTACT SPACING ( mm ) | |
|---|---|---|
| | Air Spacing | Creepage Distance |
| (1) | (2) | (3) |
| Instrument | — | 1·59 |
| A | 1·59 | 3·18 |
| D | 3·18 | 4·77 |
| E | 4·77 | 6·35 |
| B | 6·35 | 7·94 |
| C | 7·94 | 25·4 |

**3.6.2.6** *Contact for hermetically sealed connectors* — Contact shall be fused into the vitreous inserts of hermetically sealed connectors. A resilient face gasket shall be permanently bonded to the insert to ensure an interfacial seal in mating with an environmental resistant counterpart connector.

**3.6.3** *Shell Design* — Connector shells shall be seamless except for hermetically sealed connectors and shall retain their inserts in a positive manner.

**3.6.3.1** *Lubrication* — All threads except those surfaces which are intended to provide potting compound anchorage shall be coated with a suitable lubricant.

**3.6.3.2** *Coupling connections* — Threaded coupling rings shall be knurled and shall be so designed that the male and female contacts will engage or disengage as the ring is respectively tightened or loosened. The coupling rings of crimp contact connector plug shall be captive to the shell. The quick disconnect coupling shall be provided with suitable gripping surfaces and shall be fastened to the sockets by means of a device which engages the socket threads but can be pulled free in case of an emergency.

**3.6.3.3** *Safety of coupling rings* — All threaded coupling rings shall be designed for safety wiring. At least two holes shall be provided for shell size 14 and smaller, and at least three equally spaced holes for connector size 16 and larger. The holes shall be of a diameter sufficient to accommodate 0·80 mm diameter wire.

**3.6.3.4** *Shell polarization* — Polarization of connectors shall be accomplished by matched integral key and keyway of counterpart connectors. The polarisation of counterpart connectors shall take place before coupling rings are engaged.

**3.6.3.5** *Engagement seal ( connectors with resilient interfaces )* — Connectors with resilient interfaces shall contain sealing means so that engaged connectors comply with the requirements specified herein. The design of the seal shall be such that in mated connectors, all air paths between adjacent contacts and between contacts and shells are eliminated. There shall be interfacial mating of the engaged connector insert to provide dielectric under compression of 0·130 mm, minimum. Connector plug shells with threaded coupling rings shall be provided with a static peripheral seal to ensure shell to shell sealing.

**3.6.4** *Wire Sealing*

**3.6.4.1** Connectors, other than box mounting sockets, shall be provided with a wire sealing grommet capable of sealing on wires of sizes specified in Table 2.

## TABLE 2 WIRE RANGE ACCOMMODATION

( *Clause* 3.6.4.1 )

| CONTACT SIZE | WIRE SIZE | OD OF FINISHED WIRE ( mm ) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Solder Contact | | Crimp Contact | | | |
| | | | | Front release | | Rear release | |
| | | *Min* | *Max* | *Min* | *Max* | *Min* | *Max* |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| 16–16 | 0·800<br>1·000<br>1·25 | 1·63 | 3·30 | 1·68 | 3·30 | 1·35 | 2·61 |
| 12–12 | 1·60<br>2·00 | 2·90 | 4·32 | 2·47 | 4·32 | 2·16 | 4·01 |
| 8–8 | 2·50<br>3·15 | 4·17 | 6·48 | 3·36 | 6·48 | 3·36 | 6·48 |
| 4–4 | 4·00<br>5·00 | 6·90 | 9·40 | 6·02 | 9·40 | 6·02 | 9·40 |
| 0–0 | 6·30<br>8·00 | 10·55 | 13·98 | 9·14 | 13·98 | 9·14 | 13·97 |

a) *Solder contact connectors* — Environment resistant solder contact connectors shall be provided with a removable resilient grommet and retaining feature. The grommet shall be designed to fit firmly against the rear face of the insert with the retaining feature in the installed condition.

b) *Crimp contact connectors* — Crimp contact connectors shall be provided with an integral grommet and insert.

**3.6.4.2** *Hermetically sealed connectors* — Hermetically sealed connectors shall not be supplied with a wire sealing grommet. However, the shells and inserts shall be so designed that potting compound will adhere to the insert without treatment by the user.

**3.6.4.3** *Grommet sealing plug* — The grommets of connectors shall be so designed to accept sealing plugs in lieu of wires where unused contacts are employed.

### 3.6.5 *Interchangeability and Intermateability*

**3.6.5.1** *Interchangeability* — All connectors and accessories shall be completely interchangeable with each other with respect to installation and performance.

**3.6.5.2** *Intermateability* — Connectors conforming to this specification shall be intermateable. When different types of connectors ( front or rear release ) or different types of contacts ( crimp or solder ) are used in mated pair connectors, the minimum performance requirement must be met.

**3.6.6** *Cover Cap and Chain Assemblies* — To provide protection against live circuits and to keep dirt and dust out when connectors are not in use, cap and chain assemblies shall be used.

**3.6.7** *Cable Clamps* — To avoid strain due to twisting and pulling at the soldered terminations, cable clamps shall be used, where necessary.

## 4. TYPE DESIGNATION

**4.1** The insert is identified by a code letter as shown below:

| *Insert* | *Code Letter* |
|---|---|
| Insert with male contacts | M |
| Insert with female contacts | F |

**4.2** A connector according to this standard shall be designated by:

a) Reference to this Indian Standard;

b) The letters IS representing Indian Standard;

c) A number denoting the type of connector;

d) A number denoting the variant which indicates shell size, insert arrangement number, orientation and type of insert; and

e) A letter denoting the type of contact.

**4.3** The type designation shall be given in accordance with **4.2.** For example

XXXX IS — YY — ZZ — M/F

where

XXXX represents the reference number of Indian Standard (IS);
YY denotes the number allotted to the type of connector;
ZZ denotes the variant for denoting shell size, etc; and
M/F denotes the insert with male contacts/female contacts.

## 5. MARKING

**5.1** The connectors shall be maked in accordance with **6** of IS : 9647-1986*.

## 6. CLIMATIC CATEGORY

**6.1** The climatic category shall generally be chosen in accordance with 3 of IS : 9647-1986*.

**6.2** The climatic category of a particular connector shall be specified in the relevant specification.

## 7. ELECTRICAL RATINGS

**7.1** The rated voltage, rated current and test voltage ( voltage proof ) shall be specified in the relevant specification.

## 8. TESTS

**8.1 General** — The test schedule specifies the tests, the order in which they shall be carried out and the requirements to be met.

**8.2 Conditions of Tests** — The provisions of **8** of IS : 9647-1986* shall apply.

**8.3 Classification of Tests** — The provisions of **7** of IS : 9647-1986* shall apply.

### 8.4 Test Schedule

**8.4.1** *Type Tests* — The test schedules for type tests in respect of solder contact connectors and crimp contact connectors, the sequence of tests and the number of samples shall be as specified in Tables 3 and 4.

**8.4.2** *Routine Tests* — The following tests shall be carried out in the order stated :

a) Visual examination ( *see* **9** of IS : 9647-1986* ).

b) Voltage proof ( duration 5 seconds ) ( *see* **12.5** of IS : 9647-1986*).

**8.4.3** *Acceptance Tests* — Two groups of samples ( Group A and Group B ) shall be selected preferably at random from the lot that has passed routine tests stated in **8.4.2**. Each group of connectors shall be subjected to the tests in order given in Table 5.

---

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

## TABLE 3 SCHEDULE OF TYPE TESTS FOR SOLDER CONTACT CONNECTORS

( *Clause* 8.4.1 )

| SL No. | TESTS | CLAUSE REF OF IS : 9647-1986* | CONDITIONS OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| (1) | (2) | (3) | (5) | (6) |
| 1. | All samples ( 22 samples ) | | | |
| | a) Visual examination | 9 | — | — |
| | b) Dimensions and mass | 10 | — | — |
| | c) Polarization | 13.14 | | |
| | i) Polarizing device | 13.14.1 | — | — |
| | ii) Mismating | 13.14.2 | 110 N, *Max* | — |
| | iii) Orientation | 13.14.3 | — | — |
| | d) Insertion and withdrawal force | 14.1 | — | — |
| | e) Magnetic permeability | 12.11 | As specified. This test is not applicable to fireproof, hermetically sealed and connectors with thermocouple contacts. Connectors may be wired or unwired but should not be carrying current | The relative permeability shall be less than 2 |
| | f) Low level circuit | B-2 | — | — |
| | g) Contact resistance | 12.1 | *See* Appendix B | *See* relevant specification |
| | h) Voltage proof | 12.5 | *See* relevant specification | There shall be no breakdown or flash over |
| | j) Insulation resistance | 12.4 | 500 ± 50V | 5 000 MΩ, *Min* |
| | k) Sealing | 16.5 | — | The rate of leakage shall not exceed 1 atm cc/hour |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

( *Continued* )

### TABLE 3 SCHEDULE OF TYPE TESTS FOR SOLDER CONTACT CONNECTORS — *Contd*

| SL No. | TESTS | CLAUSE REF OF IS : 9647-1986* | CONDITION OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| 2. | First group ( 6 samples ) | | | |
| | a) Dimensions and mass | 10 | — | — |
| | b) Soldering | 13.15 | — | — |
| | c) Bump | 14.11 | 4 000 ± 10 humps, 400 m/s² and pulse duration 6 ms | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | ii) Visual examination | 9 | — | — |
| | d ) Vibration | 14.13 | 0·75 mm or 500 m/s² and duration 10 h | — |
| | i) Visual examination | 9 | — | — |
| | ii) Contact resistance | 12.1 | — | *See* 1 ( g ) |
| | e ) Shock | 14.12 | 500 m/s² | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | ii) Visual examination | 9 | — | — |
| | f) Acceleration ( steady state ) | 14.10 | 170 m/s² | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | ii) Sealing | 16.5 | — | *See* 1 ( k) |
| | iii) Visual examination | 9 | — | — |
| | g) Rapid change of temperature | 16.4 | — | — |
| | i ) Voltage proof | 12.5 | *See* 1 ( h ) | — |
| | ii ) Visual examination | 9 | — | — |
| | h) Dry heat | 16.2.1 | *See* relevant specification | — |
| | i ) Visual examination | 9 | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

( *Continued* )

## TABLE 3 SCHEDULE OF TYPE TESTS FOR SOLDER CONTACT CONNECTORS — *Contd*

| SL No. | TESTS | CLAUSE REF OF IS : 9647-1986* | CONDITIONS OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| j) | Damp heat accelerated ( first cycle ) | 16.2.2 | One cycle | — |
| | i) Visual examination | 9 | — | — |
| k) | Cold | 16.2.3 | *See* relavant specification | — |
| | i) Visual examination | 9 | — | — |
| | ii) Insertion and withdrawal force | 14.1 | — | — |
| m) | Low air pressure | 16.2.4 | *See* relevant specification | — |
| | i) Voltage proof | 12.5 | *See* 1 ( h) | — |
| n) | Damp heat accelerated ( remaining cycle ) | 16.2.5 | Five cyles | — |
| | i) Low level circuit | B-2 | — | — |
| | ii) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | iii) Voltage proof | 12.5 | *See* 1 ( h ) | — |
| | iv) Insulation resistance | 12.4 | 500 ± 50 V | 100 MΩ, *Min* |
| | v) Insertion and withdrawal force | 14.1 | — | — |
| | vi) Sealing | 16.5 | — | *See* 1 ( k ) |
| | vii) Visual examination | 9 | — | — |
| p) | Probe damage test ( size 16 contacts only ) | 13.1.2 | *See* Appendix C | — |
| | i) Visual exmination | 9 | — | — |
| | ii) Insertion and withdrawal force | 14.1 | — | — |
| q) | Resistance to contaminating fluids | 16.5.5.1 | As specified, except voltage proof test shall not be applied | Connector shall engage and disengage satisfactorily |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

( *Continued* )

## TABLE 3 SCHEDULE OF TYPE TESTS FOR SOLDER CONTACT CONNECTORS — *Contd*

| SL No. | TESTS | CLAUSE REF OF IS : 9647-1986* | CONDITIONS OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| | r) Insert retention ( in shell ) | 14.7 | *See* Appendix D | The insert shall not be dislodged from their original position or be damaged |
| | s) Contact retention ( in insert ) | 14.4 | *See* Appendix E | *See* Appendix C |
| | t) External bending moment | 14.3.2 | *See* Appendix F | — |
| 3. | Second group ( 4 samples ) | | | |
| | a) Damp heat ( long-term exposure ) | 16.3 | *See* relevant specification | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | ii) Voltage proof | 12.5 | *See* 1 ( h ) | — |
| | iii) Insulation resistance | 12.4 | 500 ± 50 V | 100 MΩ, *Min* |
| | iv) Sealing | 16.5 | — | *See* 1 ( k ) |
| | v) Visual examination | 9 | — | — |
| 4. | Third group ( 4 samples ) | | | |
| | a) Mechanical endurance test ( on locking device ) | 17 | 600 operations Coupling ring shall be completely engaged and disengaged twice per minute | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | ii) Insertion and withdrawal force | 14.1 | — | — |
| | iii) Visual examination | 9 | — | — |
| | iv) Screen continuity | 12.3 | — | 50 mΩ, *Max* |
| | b) Electrical endurance test | 18 | 1 000 h at 125°C | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) above |
| | ii) Voltage proof | 12.5 | *See* 1 ( h ) above | — |
| | iii) Insulation resistance | 12.4 | — | 100 MΩ, *Min* |
| | iv) Sealing | 16.5 | — | *See* 1 ( k ) above |
| | v) Visual examination | 9 | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

(*Continued*)

TABLE 3 SCHEDULE OF TYPE TESTS FOR SOLDER CONTACT CONNECTORS — *Contd*

| SL No. | TESTS | CLAUSE REF OF IS : 9647-1986* | CONDITIONS OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| 5. | Fourth group ( 2 samples ) | | | |
| | a) Mould growth | 16.6 | — | — |
| 6. | Fifth group ( 2 samples ) | | | |
| | a) Salt mist | 16.7 | — | — |
| | i) Low level circuit | B-2 | — | — |
| | ii) Contact resistance | 12.1 | *See* Apppendix B | *See* 1 ( g ) |
| | iii) Voltage proof | 12.5 | *See* 1 ( h ) | |
| | iv) Insulation resistance | 12.4 | — | 100 MΩ, *Min* |
| | v) Insertion and withdrawal force | 14.1 | — | — |
| | vi) Visual exmination | 9 | — | — |
| | b) Dust | 16.8 | — | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 ( g ) |
| | ii) Visual examination | 9 | — | — |
| 7. | Sixth group ( 2 samples ) | | | |
| | a) Effect of cable rotation | 15.1 | Cable length 600 mm, No. of revolutions 100 | — |
| | b) Effectiveness of cable clamping device against cable pulling | 15.2 | Cable length 250 mm, pulling force 200 N and duration 2 minutes | — |
| | c) Effectiveness of cable clamping device against cable bending | 15.3 | Cable length 200 mm, distance 156 mm, bending force 100 N, No. of bends 50 | — |
| | d) Effectiveness of cable clamping device against cable torsion | 15.4 | Cable length 100 mm, and torque 10 Nm | — |
| 8. | Seventh group ( 2 samples ) | | — | — |
| | a) Fire proofness ( for fire proof connectors only ) | 16.10 | | |
| 9. | Eighth group ( 8 sample of female contacts ) | | | |
| | a) Contact engagement and separation force | 13.6 | *See* Appendix G | *See* Appendix G |
| | b) Probe damage test | 13.1.2 | *See* Appendix C | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

## TABLE 4 SCHEDULE OF TYPE TESTS FOR CRIMP CONTACT CONNECTORS

( *Clause* 8.4.1 )

| Sl No. | Tests | Clause Ref of IS : 9647-1986* | Condition of Test | Requirements |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (6) |
| 1. | All samples ( 22 samples ) | | | |
| | a) Visual examination | 9 | — | — |
| | b) Dimensions and mass | 10 | — | — |
| | c) Polarization | 13.14 | — | — |
| | i) Polarizing device | 13.14.1 | — | — |
| | ii) Mismating | 13.14.2 | 110 N, *Max* | — |
| | d) Contact insertion and removal force | 13.5 | *See* Appendix H | *See* Appendix H |
| | e) Magnetic permeability | 12.11 | *See* Table 3, 1 (e) | *See* Table 3, 1(e) |
| | f) Low level circuit | B-2 | — | — |
| | g) Contact resistance | 12.1 | *See* Appendix B | *See* relevant specification |
| | h) Shell to shell continuity | 19.2 | — | — |
| | j) Voltage proof | 12.5 | *See* relevant specification | — |
| | k) Insulation resistance | 12.4 | 500 ± 50 V | 5 000 MΩ, *Max* |
| | m) Sealing | 16.5 | — | The rate of leakage shall not exceed 1 atm cc/hour |
| 2. | First group ( 6 samples ) | | | |
| | a) Dimensions and mass | 10 | — | — |
| | b) Bump | 14.11 | 4 000 ± 10 bumps, 400 m/s$^2$ and pulse duration 6 ms | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | c) Vibration | 14.13 | 10 to 500 Hz, 0·75 mm or 500 m/s$^2$ and duration 10 h | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | ii) Visual examination | 9 | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

(*Continued*)

TABLE 4 SCHEDULE OF TYPE TESTS FOR CRIMP CONTACT CONNECTORS — *Contd*

| SL No. | TESTS | CLAUSE REF OF IS : 9647-1986* | CONDITIONS OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| d) | Shock | 14.12 | 500 m/s² | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | ii) Visual examination | 9 | — | — |
| e) | Acceleration (steady state ) | 14.10 | 170 m/s² | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (m) |
| | ii) Sealing | 16.5 | — | *See* 1 (m) |
| f) | Rapid change of temperature | 16·4 | *See* relevant specification | — |
| g) | Dry heat | 16.2.1 | *See* relevant specification | — |
| | i) Visual examination | 9 | — | — |
| h) | Damp heat accelerated ( first cycle ) | 16.2.2 | One cycle | — |
| | i) Visual examination | 9 | — | — |
| j) | Cold | 16.2.3 | *See* relevant specification | — |
| | i) Visual examination | 9 | — | — |
| k) | Low air pressure | 16.2.4 | *See* relevant specification | — |
| | i) Voltage proof | 12.5 | *See* 1 (h) | — |
| m) | Damp heat accelerated ( remaining cycle ) | 16.2.5 | Five cycles | — |
| | i) Low level circuit | B-2 | — | — |
| | ii) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | iii) Voltage proof | 12.5 | *See* 1 (h) | — |
| | iv) Insulation resistance | 12.4 | 500 ± 50 V | 100 MΩ, *Min* |
| | v) Insertion and withdrawal force | 14.1 | — | — |
| | vi) Sealing | 16.5 | — | *See* 1 (m) |
| | vii) Visual examination | 9 | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

( *Continued* )

## TABLE 4 SCHEDULE OF TYPE TESTS FOR CRIMP CONTACT CONNECTORS — *Contd*

| Sl No. | Tests | Clause Ref of IS : 9647-1986* | Condition of Test | Requirements |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| | n) Resistance to contaminating fluids | 16.5.5.1 | As specified except voltage proof test shall not be applied | Connectors shall engage and disengage satisfactorily |
| | p) Insert retention ( in shell ) | 14.7 | *See* Appendix D | The insert shall not be dislodged from their original position or be damaged |
| | q) Contact retention ( in insert ) | 14.4 | *See* Appendix E | *See* Appendix E |
| | r) External bending moment | 14.3.2 | *See* Appendix F | — |
| 3. | Second group ( 4 samples ) | | | |
| | a) Damp heat ( long-term exposure ) | 16.3 | Duration 21 days | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | ii) Voltage proof | 12.5 | *See* 1 (h) | — |
| | iii) Insulation resistance | 12.4 | 500 ± 50 V | 100 MΩ, *Min* |
| | iv) Sealing | 16.5 | — | *See* 1 (m) |
| | v) Visual examination | 9 | — | — |
| 4. | Third group ( 4 samples ) | | | |
| | a) Mechanical endurance test | 17 | *See* 4 (a) ( Table 3 ) | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | ii) Insertion and withdrawal force | 14.1 | — | — |
| | iii) Visual examination | 9 | — | — |
| | b) Electrical endurance test | 18 | 1 000 h at 125°C | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | ii) Voltage proof | 12.5 | *See* 1 (h) above | — |
| | iii) Insulation resistance | 12.4 | — | 100 MΩ, *Min* |
| | iv) Sealing | 16.5 | — | *See* 1 (m) |
| | v) Visual examination | 9 | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc (*first revision*).

( *Continued* )

## TABLE 4 SCHEDULE OF TYPE TESTS FOR CRIMP CONTACT CONNECTORS — *Contd*

| SL No. | TESTS | CLAUSE REF OF IS : 9647 1986* | CONDITIONS OF TEST | REQUIREMENTS |
|---|---|---|---|---|
| 5. | Fourth group ( 2 samples ) | | | |
| | a) Mould growth | 16.6 | — | — |
| 6. | Fifth group ( 2 samples ) | | | |
| | a) Salt mist | 16.7 | — | — |
| | i) Low level circuit | B-2 | — | — |
| | ii) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | iii) Voltage proof | 12.5 | *See* 1 (h) | — |
| | iv) Insulation resistance | 12.4 | — | 100 MΩ, *Min* |
| | v) Insertion and withdrawal force | 14.1 | — | — |
| | vi) Visual examination | 9 | — | — |
| | b) Dust | 16.8 | — | — |
| | i) Contact resistance | 12.1 | *See* Appendix B | *See* 1 (g) |
| | ii) Visual examination | 9 | — | — |
| 7. | Sixth group ( 2 samples ) | | | |
| | a) Effect of cable rotation | 15.1 | Cable length 600 mm; No. of revolutions 100 | — |
| | b) Effectiveness of cable clamping device against cable pulling | 15.2 | Cable length 250 mm; pulling force 200 N and duration 2 min | — |
| | c) Effectiveness of cable clamping device against cable bending | 15.3 | Cable length 200 mm : distance 150 mm; bending force 100 N and No. of bends 50 | — |
| | d) Effectiveness of cable clamping device against cable torsion | 15.4 | Cable length 100 mm; and torque 10 Nm | — |
| 8. | Seventh group ( 2 samples ) | | | |
| | a) Fireproofness ( for fireproof connectors only ) | 16.10 | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

## TABLE 5 SCHEDULE OF ACCEPTANCE TESTS FOR SOLDER CONTACT CONNECTORS AS WELL AS CRIMP CONTACT CONNECTORS

( *Clause* 8.4.3 )

| TESTS | CLAUSE REF OF IS : 9647-1986* | AQL (PERCENT DEFECTIVE) | INSPECTION LEVEL (IS : 10673-1983†) | D/ND‡ |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| *Group A* | | | | |
| Insertion and withdrawal force | 14.1 | 1 | II | ND |
| Contact resistance | 12.1 | — | — | — |
| Insulation resistance | 12.4 | — | — | — |
| Sealing | 16.5 | — | — | — |
| *Group B* | | | | |
| *Sub-group* 1 | | | | |
| Dimensions and mass | 10 | 4 | S-3 | ND |
| *Sub-group* 2 | | | | |
| Mechanical endurance test ( short-term ) | 17 | 4 | S-3 | ND |
| Electrical endurance test ( short-term ) | 18 | — | — | — |
| *Sub-group* 3 | | | | |
| Contact insertion and removal force ( for removable contacts only | 13.5 | 4 | S-3 | D |
| Soldering ( for solder contact connectors only ) | 13.15 | — | — | — |

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

†Sampling plans and procedures for inspection by attributes for electronic items.

‡D stands for destructive tests and ND for non-destructive tests.

( *Continued* )

## TABLE 5 SCHEDULE OF ACCEPTANCE TESTS FOR SOLDER CONTACT CONNECTORS AS WELL AS CRIMP CONTACT CONNECTORS — *Contd*

| TESTS | CLAUSE REF OF IS : 9647-1986[*] | AQL (PERCENT DEFECTIVE) | INSPECTION LEVEL (IS : 10673-1983[†]) | D/ND[‡] |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Bump | 14.11 | — | — | — |
| Climatic sequence | 16.2 | — | — | — |
| Insert retention ( in shell) ( for crimp contact connectors only ) | 14.7 | — | — | — |
| Contact retention ( in shell ) | 14.4 | — | — | — |
| *Sub-group* 4 | | | | |
| Salt mist | 16.7 | — | — | — |
| *Sub-group* 5 | | | | |
| Contact engagement and separation force | 13.6 | 8 specimens of female contacts of the size used in the connector, shall be tested. Failure of one or more contact shall constitute rejection of the test lot | | |
| Probe damage test ( size 16 only ) | 13.1.2 | | | |

NOTE — Samples which have been subjected to destructive tests shall not be returned to the lot.

[*] General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

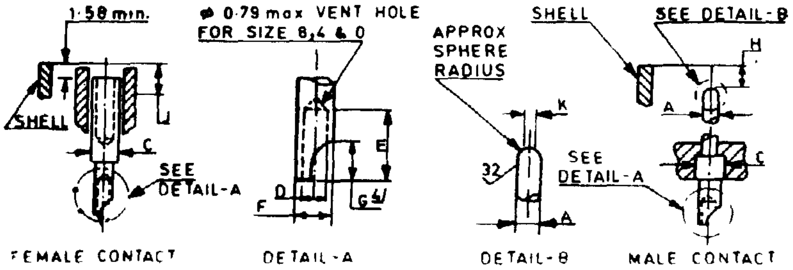
[†] Sampling plans and procedures for inspection by attributes for electronic items.

[‡] D stands for destructive tests and ND for non-destructive tests.

# APPENDIX A

( *Clause* 3.6.1.1 )

## SOLDER CONTACTS



FEMALE CONTACT DETAIL-A DETAIL-B MALE CONTACT

NOTE — For dimensions, *see* Table 5.

1) Applies after plating.

2) Used for calculating mechanical spacing between contacts, and beween contacts and shell.

3) Represents the distance from the end of the shell to the point at which the mating pin engages the socket contact spring.

4) Sizes 12 and 16 : G *Max* = 2/3, radius of cutout optional. Size 0, 4 and 8 : Cutout optional.

5) Dimensions shown are typical for shell sizes 10 SL, 14 S and 16 S.

FIG. 1 SOLDER CONTACTS ( MALE AND FEMALE )

## TABLE 6 DIMENSIONS FOR SOLDER CONTACTS

All dimensions in millimetres.

| CONTACT SIZE | *A*[1] ± 0·025 | DIA *C*[2] *Max* | DIA *D* *Min* | *E* + 1·6 −0·00 | DIA *F* |  | *H* (PLUG AND SOCKET) |  | *J*[3] (PLUG AND SOCKET) *Max* | DIA OF FLAT, *K* |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | *Min* | *Max* | *Min* | *Max* |  |  |
| 16 | 1·58 | 3·23 | 1·75 | 6·35 | 2·44 | 2·95 | 6·35 | 7·92 | 7·14 | 0·38 |
| 16 S[4] | 1·58 | 3·23 | 1·75 | 6·35 | 2·44 | 2.95 | 1·57 | 3·18 | 7·14 | 0·38 |
| 12 | 2·39 | 4·83 | 2·84 | 9·53 | 3·30 | 3·81 | 1·57 | 3·18 | 9·53 | 0·38 |
| 8 | 3·61 | 7·87 | 5·21 | 12·7 | 6·17 | 6·58 | 1·57 | 3·18 | 9·53 | 3·38 |
| 4 | 5·72 | 11·20 | 8·33 | 15·88 | 9·40 | 10·08 | 1·57 | 3·18 | 9·53 | 2·67 ± 0·53 |
| 0 | 9·07 | 15·16 | 11·79 | 15·88 | 12·95 | 13·97 | 1·57 | 3·18 | 7·14 | 6·02 ± 0·53 |

[1] Applies after plating.

[2] Used for calculating mechanical spacing between contact and shell.

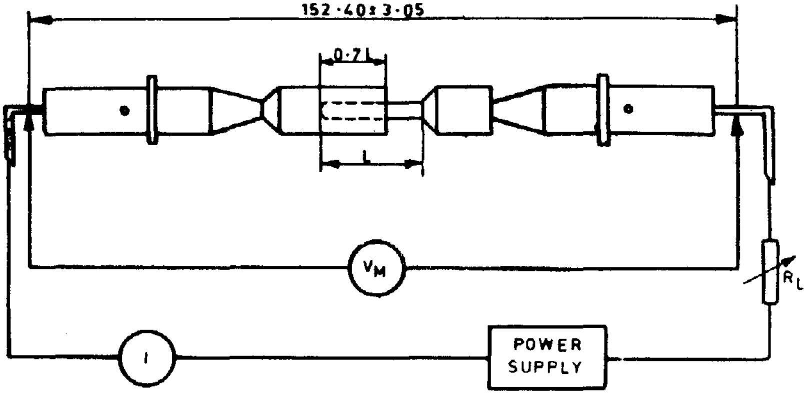
[3] Represents the distance from the end of the shell to the point at which the mating pin engages the socket contact spring.

[4] Dimensions shown are typical for shell size 10 S, 10 SL, 12 S, 14 S and 16 S.

# APPENDIX B

( *Tables* 3 *and* 4 )

## CONTACT RESISTANCE



All dimensions in millimetres.

FIG. 2 TEST CIRCUIT FOR CONTACT RESISTANCE MEASUREMENT ( VOLTAGE DROP )

**B-1. Condition of Test** — The following details shall apply:

a) *Voltmeter* — Ammeter method shall be applied as shown in Fig. 2. The circuit shall be calibrated to measure 0·01 ohm standard precision resistor at a load current of 1 ampere with ± 4 percent accuracy.

b) The current limiting resistor 'RL' shall be added to the test circuit as required to limit the current to the applicable test current as specified in Appendix D. The test current shall be passed through each contact pair only long enough to permit measuring the voltage drop.

c) Number of activations prior to measurement — Not applicable.

d) Number of measurements per activation — Not applicable.

# APPENDIX C

### [ *Table* 3, *Items* 2 ( p ) *and* 9 ( b ) ]

## PROBE DAMAGE TEST

**A-1. Condition of Test** — A test probe shall be inserted into each female contact to the depth shown below and the applicable bending moment applied. The removable contacts shall be suitably supported to prevent bending but the support shall not reinforce the pressure member. The test probe shall consist of hardened steel pin having a diameter equal to the nominal dimensions of the mating pin contact and a spherical radius tip. The test probe shall be free and unsupported at each specified depth, the contact shall be rotated one complete revolution at a uniform rate.

| *Contact Size* | *Depth of Insertion* | | | *Bending moment* |
|---|---|---|---|---|
| | 1/2 | 3/4 | Full | ± 10 percent |
| 16 | X | X | X | 0·23 Nm |

X indicates applicable.

# APPENDIX D

### [ *Table* 3, *Item* 2 ( r ) *and Table* 4, *Item* 2 ( p ) ]

## INSERT RETENTION ( IN SHELL )

**D-1. Conditions of Test** — As specified in **14.7** of IS : 9647-1986*. The following details and exceptions shall apply:

a) The pressure shall be applied at a rate of 69 kPa/s.

b) The insert shall retain the pressure for 5 seconds.

c) The axial force applied shall be as follows:

---

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

| *Shell size* | *Pressure in kPa*<br>All, except hermetically sealed | *Pressure in kPa*<br>Hermetically sealed |
|---|---|---|
| 8 to 12 | 1 034·25 | |
| 14 to 18 | 689·5 | |
| 20 to 22 | 517·13 | 1 379 |
| 24 to 28 | 413·70 | |
| 32 to 40 | 310·27 | |
| 44 to 48 | 206·85 | |

NOTE — For other shell sizes :

a) Rate of applied force — 44·48 N/s.

b) Maximum force — 220 N.

# APPENDIX E

## [ *Table* 3, *Item* 2 ( s ) *and Table* 4, *Item* 2 ( g ) ]

## CONTACT RETENSION ( IN INSERT )

**E-1. Conditions of Test** — As specified in **14.4** of IS : 9647-1986*. An axial load as specified below, shall be applied at a rate of 450 g/s until the specified load has been reached. A minimum of 20 percent, but not less than three, of the contacts in each connector shall be tested. Axial load shall be applied to individual contacts. The connector shall have all contacts in place during the test.

a) *Crimp Contact Connectors* (*Accessory Tightened*) — The axial load shall be applied to the mating end of the contacts with the connector accessories tightened. The load shall be applied after the slack in the contact has been taken up, and the displacement of the contacts shall be measured under load after the load has been applied for 5 seconds, *Min*.

---

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

b) *Crimp Contact Connectors ( Accessories Removed )* — Connectors shall be tested as in (a) except that the accessories shall be removed prior to test, and load shall be applied in each direction in turn. Special contacts may be substituted for this test. The special contacts shall conform to the requirements given in relevant specification, except that a solid rod may be attached to the contacts instead of wire. The solid rod diameter shall be within the specified wire insulation diameter. Contact cavities not filled with rod contact assemblies shall be filled with wired contacts.

c) *Solder Contact Connectors* — Connectors shall be tested as in (a) except that the grommet retaining nut shall be loose and measurements of displacement of the contacts are not required. Contact retention axial loads shall be as given below.

| *Contact Mating End Size* | *Minimum Axial Loads, kg* | |
|---|---|---|
| | Fixed Contacts | Removable Contacts |
| 16 | 4·54 | 11·35 |
| 12 | 6·81 | 11·35 |
| 8 | 9·08 | 18·16 |
| 4 | 9·08 | 22·70 |
| 0 | 11·35 | 22·70 |

NOTE — Contact retention axial load for other contacts — 4·54 kg per contact.

**E-2. Requirements** — The contacts shall be retained in their inserts when subjected to the loads. The axial displacement of crimp contacts shall not exceed 0·63 mm with reference to the shell while under load.

## APPENDIX F

[ *Table* 3, *Item* 2 ( t ) *and Table* 4, *Item* 2 ( r ) ]

### EXTERNAL BENDING MOMENT

**F-1. Conditions of Test** — As specified in **14.3.2** of IS : 9647-1986*.

---

*General requirements and methods of tests for low frequency connectors below 3 MHz including dc ( *first revision* ).

External bending moment shall be applied as follows:

| *Shell Size* | *Bending Moment, Nm* |
|---|---|
| 8 and 8 S | 4·52 |
| 10 S and 10 SL | 10·17 |
| 12 S and 12 | 20·34 |
| 1, 14 S and 14 | 22·60 |
| 16 S and 16 | 28·25 |
| 2 and 18 | 31·64 |
| 3 and 20 | 33·90 |
| 22 | 39·55 |
| 24 | 42·94 |
| 28 | 47·46 |
| 32 | 56·50 |
| 36 | 61·02 |
| 40 | 65·54 |
| 44 | 70·06 |
| 48 | 74·58 |

# APPENDIX G

[ *Table* 3, *Item* 9 (a) ]

## CONTACT ENGAGEMENT AND SEPARATION FORCE

### G-1. Conditions of Test

a) Female contacts shall be mounted in a suitable fixture for applying gradually increasing loads, for engagement and separation of specified gauge pins of maximum and minimum diameter ( *see* Fig. 4 ). The test pins shall be inserted to a depth of minimum 7 *L* ( *see* Fig. 3 ).

b) The female contact shall be conditioned by inserting and withdrawing the force gauge one time.

c) The maximum diameter test pin shall be inserted. The engagement force shall be measured during insertion. The pin shall then be removed.

d) The minimum diameter test pin shall be inserted and removed. The separation force shall be measured as the pin is withdrawn.

e) The test pins shall be cleaned periodically to remove any foreign surface film which may affect the engagement and separation forces recorded.

f) Contacts may be tested installed in the connector inserts. During the test, each female contact, whether assembled or individual, shall be aligned with the test pin similar to actual conditions in the field.

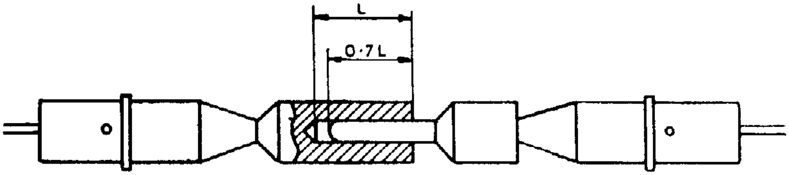


FIG. 3 DEPTH OF INSERTION FOR CONTACT ENGAGEMENT AND SEPARATION FORCE

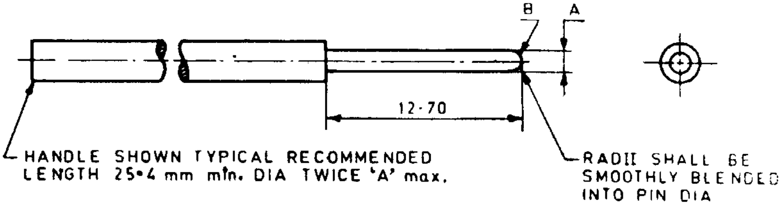

B
A
12·70
HANDLE SHOWN TYPICAL RECOMMENDED LENGTH 25·4 mm min. DIA TWICE 'A' max.
RADII SHALL BE SMOOTHLY BLENDED INTO PIN DIA

FIG. 4 GAUGE PIN FOR CONTACT ENGAGEMENT AND SEPARATION FORCE TEST

**TABLE 6 DIMENSIONS FOR GAUGE PIN**

( *Fig.* 4 )

| CONTACT SIZE | A | | B |
|---|---|---|---|
| | Minimum Diameter Pin<br>+ 0·002 5<br>—0·000 0 | Maximum Diameter Pin<br>+ 0·000 0<br>—0·002 5 | MAXIMUM FLAT |
| 16 | 1·562 1 | 1·612 9 | 0·381 |
| 12 | 2·362 2 | 2·413 0 | 0·381 |
| 8 | 3·581 4 | 3·632 2 | 0·762 |
| 4 | 5·689 6 | 5·740 4 | 0·762 |
| 0 | 9·042 4 | 9·093 2 | 1·524 |

NOTE 1 — All dimensions are in mm.

NOTE 2 — Material for gauge pin : Tungsten carbide; and for handle is optional.

NOTE 3 — Finish : 0·15 to 0·25 μm, rms.

NOTE 4 — Plating : none.

**G-2.** *Requirements* — Contact engagement and separation forces shall be within the following limits, as applicable:

| *Contact Size* | *Minimum Separation Force, N* | *Maximum Average Engagement Force, N* | *Maximum Engagement Force, N* |
|---|---|---|---|
| 16 | 0·5 | 9·2 | 13·2 |
| 12 | 0·8 | 15·4 | 22 |
| 8 | 1·3 | No requirement | 44 |
| 4 | 2·7 | | 66 |
| 0 | 4·1 | | 88 |

# APPENDIX H

[ *Table* 4, *Item* 1 (d) ]

## CONTACT INSERTION AND REMOVAL FORCE

## ( FOR REMOVABLE CONTACTS ONLY )

**H-1. Conditions of Test** — With the grommet, a minimum of 20 percent, but not more than 3, of the contacts shall be removed and re-inserted using the applicable tool. The forces required to insert and remove the unlocked contacts shall be measured. Counterpart connectors shall be engaged and disengaged 10 times. The same contacts shall then be removed and re-inserted for nine more times. The insertion and removal force shall be measured during the ninth cycle on half ( but not less than three ) of the contacts selected for this test.

**H-2. Requirements** — The force required to insert and remove the unlocked contacts shall not exceed the following:

| *Contact Size* | *Insertion and Removal Force, N, Max* |
|---|---|
| 16 | 88·96 |
| 12 | 111·20 |
| 8 | 133·44 |
| 4 | 177·92 |
| 0 | 177·92 |

# INTERNATIONAL SYSTEM OF UNITS ( SI UNITS )

## Base Units

| QUANTITY | UNIT | SYMBOL |
|---|---|---|
| Length | metre | m |
| Mass | kilogram | kg |
| Time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Luminous intensity | candela | cd |
| Amount of substance | mole | mol |

## Supplementary Units

| QUANTITY | UNIT | SYMBOL |
|---|---|---|
| Plane angle | radian | rad |
| Solid angle | steradian | sr |

## Derived Units

| QUANTITY | UNIT | SYMBOL | DEFINITION |
|---|---|---|---|
| Force | newton | N | 1 N = 1 kg.m/s$^2$ |
| Energy | joule | J | 1 J = 1 N.m |
| Power | watt | W | 1 W = 1 J/s |
| Flux | weber | Wb | 1 Wb = 1 V.s |
| Flux density | tesla | T | 1 T = 1 Wb/m$^2$ |
| Frequency | hertz | Hz | 1 Hz = 1 c/s (s$^{-1}$) |
| Electric conductance | siemens | S | 1 S = 1 A/V |
| Electromotive force | volt | V | 1 V = 1 W/A |
| Pressure, stress | pascal | Pa | 1 Pa = 1 N/m$^2$ |